



**FACTORS INFLUENCING UTILISATION OF
UBIQUITOUS TECHNOLOGY AMONG UNDERGRADUATES IN
MALAYSIAN TECHNICAL UNIVERSITIES**

By

MULIATI BT. HJ. SEDEK

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
Fulfilment of the Requirement for the Degree of Doctor Philosophy**

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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AMONG UNDERGRADUATES IN MALAYSIAN TECHNICAL
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June 2014

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Ubiquitous technology such as laptops, smartphones and tablets have been widely used by many undergraduates in institutions of higher learning. However, not much is known of their utilisation level and the factors that influence its utilisation. Therefore, the main objectives of this study are to determine: i) the level of ubiquitous technology utilisation; ii) the level of competency in using ubiquitous technology, iii) whether the selected factors (technology competency, performance expectancy, effort expectancy, facilitating conditions, social status and behavioural intention) significantly influence ubiquitous technology utilisation; iv) whether behavioural intention acts as a mediator; v) whether gender acts as a moderator and finally vi) to develop a model that can predict the utilisation of ubiquitous technology among the undergraduates.

This study was based on a quantitative descriptive research using a set of questionnaire. The population of the study comprised of third-year undergraduates (N=4,247) from Malaysian Technical Universities (MTUN). Based on the Raosoft software, the minimum sample size for this study was 353 respondents. However, a total of 493 questionnaires were distributed among the undergraduates. The respondents were selected based on the proportional stratified and random sampling technique.

The research instrument was adapted from previous studies and validated by a panel of experts from the field of Educational Technology. The research instrument was divided into three sections, namely, i) demographic data, ii) ubiquitous technology utilisation and iii) factors related to the use of ubiquitous technology. The reliability of the instrument ranged from 0.83 to 0.98. The data was analysed descriptively (frequency, mean and standard deviation) using the IBM SPSS Statistics (SPSS) version 20 and inferentially using the Analysis of Moment Structures (AMOS) version 20.

The results of this study indicated that both the utilisation of ubiquitous technology and technology competency among the undergraduates were at a moderate level. The undergraduates' perceived performance expectancy, effort expectancy, behavioural intention, facilitating conditions and social status factors level were found to be high. The performance expectancy ($\beta=.485$, $p=.000$) was found to be the most salient factor influencing the utilisation of ubiquitous technology, followed by technology competency ($\beta=.306$, $p=.000$), facilitating conditions ($\beta=.216$, $p=.000$) and behavioural intention ($\beta=.156$, $p=.000$). Finally, the influences of social status ($\beta=.494$, $p=.000$) and effort expectancy ($\beta=.267$, $p=.000$) towards the utilisation of ubiquitous technology were found to be mediated by behavioural intention.

Gender factor was identified to influence effort expectancy significantly and was more significant amongst female undergraduates. The results attained from the analysis also produced a model that predicts the utilisation of ubiquitous technology among the undergraduates. The model was confirmed to account for 63% of the variance (adjusted R^2) in ubiquitous technology utilisation.

Several implications were also drawn from the results of the study. This study did not only test the Unified Theory of Acceptance and Use of Technology (UTAUT) model itself, but has been expanded by adding one variable; the technology competency from Theory of Acceptance Model (TAM). By encompassing UTAUT, one mediator and moderator, as well as technology competency; the proposed predictive model is a definitive model that synthesizes what is known and provides a foundation to guide future research in a related field of study.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**FAKTOR YANG MEMPENGARUHI PENGGUNAAN TEKNOLOGI
UBIQUITOUS DALAM KALANGAN PELAJAR DI UNIVERSITI-
UNIVERSITI TEKNIKAL DI MALAYSIA**

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Teknologi *ubiquitous* seperti komputer riba, telefon pintar dan *tablet* telah digunakan secara meluas oleh mahasiswa di institusi pengajian tinggi. Namun, tidak banyak yang diketahui tentang tahap penggunaan dan faktor-faktor yang mempengaruhi penggunaannya. Oleh itu, tujuan utama kajian ini adalah untuk menentukan: i) tahap penggunaan teknologi *ubiquitous*; ii) tahap teknologi kompetensi dalam menggunakan teknologi *ubiquitous*, iii) sama ada teknologi kompetensi, jangkaan prestasi, jangkaan usaha, keadaan memudahkan, status sosial dan niat tingkah laku mampu mempengaruhi penggunaan teknologi *ubiquitous*; iv) sama ada niat tingkah laku memainkan peranan sebagai pembolehubah pengantara, v) sama ada jantina memainkan peranan sebagai moderator, dan akhir sekali vi) membangunkan model yang boleh meramalakan penggunaan teknologi *ubiquitous* dalam kalangan mahasiswa.

Kajian ini berbentuk penyelidikan kajian deskriptif kuantitatif yang menggunakan satu set soal selidik. Populasi kajian terdiri daripada pelajar tahun ketiga (N=4,247) dari universiti-universiti Teknikal Malaysia (MTUN). Berdasarkan perisian Raosoft itu, sampel saiz minima untuk kajian ini adalah 353 responden. Walau bagaimanapun, sebanyak 493 soal selidik telah diedarkan dalam kalangan mahasiswa. Responden telah dipilih berdasarkan teknik persampelan berstrata dan rawak berkadar.

Instrumen kajian yang digunakan telah diadaptasi daripada kajian-kajian sebelum ini dan disahkan oleh satu panel pakar dari bidang Teknologi Pendidikan. Instrumen kajian terbahagi kepada tiga bahagian, iaitu i) pembolehubah demografi, ii) penggunaan teknologi *ubiquitous*, dan iii) faktor yang berkaitan dengan penggunaan teknologi *ubiquitous*. Nilai kebolehpercayaan instrumen adalah di antara 0.83 dan 0.98. Data dianalisis secara deskriptif (kekerapan, min dan sisihan piawai) dan inferensi menggunakan perisian IBM SPSS Statistics (SPSS) versi 20 dan Analysis of Moment Structures (AMOS) versi 20.

Dapatan kajian menunjukkan penggunaan teknologi *ubiquitous* dan kompetensi teknologi *ubiquitous* dalam mahasiswa didapati berada pada tahap sederhana. Tahap persepsi pelajar terhadap jangkaan prestasi, jangkaan usaha, , keadaan memudahkan dan status sosial dan niat tingkah laku didapati adalah tinggi. Jangka prestasi ($\beta=.485$, $p=.000$) dikenalpasti sebagai faktor utama mempengaruhi penggunaan teknologi *ubiquitous*, diikuti dengan kecekapan teknologi ($\beta=.306$, $p=.000$), keadaan memudahkan ($\beta = .216$, $p=.000$) dan niat tingkah laku ($\beta=.156$, $p=.000$). Akhir sekali, pengaruh status sosial ($\beta=.494$, $p=.000$) dan jangkaan usaha ($\beta=.267$, $p=.000$) terhadap penggunaan teknologi *ubiquitous* didapati dimoderasi oleh pembolehubah pengantara iaitu niat tingkah laku.

Faktor jantina telah dikenal pasti mempengaruhi faktor jangkaan usaha, dan didapati lebih signifikan dalam kalangan mahasiswa perempuan. Keputusan yang dicapai daripada analisis ini juga menghasilkan model yang meramalkan penggunaan teknologi *ubiquitous* dalam kalangan mahasiswa. Model ini disahkan mampu menjelaskan 63% daripada varians (selarasan dari R^2) dalam penggunaan teknologi *ubiquitous*.

Beberapa implikasi telah terhasil daripada kajian ini. Kajian ini bukan sahaja mampu menguji *Unified Theory of Acceptance and Use of Technology* (UTAUT), tetapi telah diperluaskan dengan menambah satu pembolehubah iaitu teknologi kompetensi yang diadaptasi dari *Theory of Acceptance Model* (TAM). Gabungan dari UTAUT, pembolehubah pengantaraan dan moderator serta kompetensi teknologi, mampu menjadikan model ramalan ini sebagai satu asas baharu dalam membantu penyelidikan dalam bidang yang sama pada masa hadapan.

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“The journey towards my goals in life is not a solo effort. I need to have Allah and people around me who believe in and support me. I believe that if I want to start the journey, stay on course and complete it successfully”.

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I certify that a Thesis Examination Committee has met on 25th June 2014 to conduct the final examination of Muliati bt. Hj. Sedek on her thesis entitled " Factors Influencing Utilisation of Ubiquitous Technology Among Undergraduates In Malaysian Technical Universities." in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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LIST OF ABBREVIATIONS

A	Attitude
AASL	American Association of School Librarians
ABET	Accreditation Board for Engineering and Technology
AECT	Association for Educational Communications and Technology
AI	Artificial Intelligence
AIC	Akaike Information Criterion
AMOS	Analysis of Moment Structures
AVE	Average Variance Extracted
BI	Behavioural Intention
CBT	Computer-Based Learning Tool
CCCT	Competency in Communication and Collaboration
CCIT	Competency in Creativity and Innovation
CCTPS	Competency in Critical Thinking, Problem-Solving and Decision Making
CD	Compact Disc
CDC	Competency in Digital Citizenship
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CMIN	Minimum Value of the Discrepancy
CMIN/DF	Minimum Discrepancy Divided by its Degrees of freedom
COCT	Competency in Operation and Concepts
CRIT	Competency in Research and Information Fluency
C.R.	Critical Ratio for Regression Weight
CR	Construct Reliability
C-TAM-TPB	Combined-TAM-TPB
CTPSCI	Competency in Critical Thinking, Creativity and Innovation Tool
DF/ <i>df</i>	Degree of Freedom
DV	Dependent Variable
e	Error
e-book	Electronic Book
ECG	Educational Computer Games
EE	Effort Expectancy
e-mail	Electronic Mail
EFA	Exploratory Factor Analysis
FC	Facilitating Conditions
GFI	Goodness-of-Fit Index
GPS	Global Positioning System
HOTS	Higher Order Thinking Skills
ICT	Information Communication and Technology
IDT	Innovation Diffusion Theory
IFI	Incremental Fit Index
IS	Information Systems

ISTE	International Society for Technology in Education
IV	Independent Variable
KPI	Key Performance Indicators
KUiTTHO	Kolej Universiti Teknologi Tun Hussein Onn
KUKUM	Kolej Universiti Kejuruteraan Utara Malaysia
KUKTEM	Kolej Universiti Kejuruteraan dan Teknologi Malaysia
KUTKM	Kolej Universiti Teknikal Kebangsaan Malaysia
LCD	Liquid Crystal Display
LMS	Learning Management System
MCMC	Malaysian Communication and Multimedia Commission
MI	Modification Indices
MM	Motivational Model
MoE	Ministry of Education
MoHE	Ministry of Higher Education
MP3	MPEG Audio Layer III
MPCU	Model of Personal Computer Utilisation
MRI	Magnetic Resonance Imaging
MS-Word	Microsoft Word
MTUN	Malaysian Technical University Network
NETS.S	National Educational Technology Standards for Students
<i>p</i>	Level of Significant
PDA	Personal Digital Assistant
PE	Performance Expectancy
PEU	Perceived Ease of Use
PLS	Partial Least Squares
PNFI	Parsimonious Normed Fit Index
POLCA	Portal of Learning Calculus
PU	Perceived Usefulness
QR-code	Quick Response Code
R ²	Squared Multiple Correlations
RAM	Random Access Memory
RFID	Radio Frequency Identification
RMSEA	Root Mean Square Error of Approximation
SCT	Social Cognition Theory
S.E	Standard Error of Regression Weight
SEM	Structural Equation Modeling
SMS	Short Message System
SNS	Social Networking Sites
SPSS	IBM SPSS Statistics
SS	Social Status
TAM	Theory of Acceptance Model
TC	Technology Competency
TNS	Taylor Nelson Sofres
TOT	Training of Trainers
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
TU	Technology Utilisation
TVET	Technical and Vocational Education and Training

UCCT	Use as Communication and Collaboration Tool
UCIT	Use as Creativity and Innovation Tool
UCTPS	Use as Critical Thinking, Problem-Solving, Decision Making Purposes
UCTPSCI	Use as Critical Thinking, Problem-Solving and Innovation Tool
UDC	Use as Digital Citizenship Tool
UIAM	Universiti Islam Antarabangsa Malaysia
UiTM	Universiti Teknologi MARA
UKM	Universiti Kebangsaan Malaysia
UM	Universiti of Malaya
UMP	Universiti Malaysia Pahang
UMS	Universiti Malaysia Sabah
UniMAP	Universiti Malaysia Perlis
UniMAS	Universiti Malaysia Sarawak
UNISEL	Universiti Industri Selangor
UPM	Universiti Putra Malaysia
USB	Universal Serial Bus
USM	Universiti Sains Malaysia
UOCT	Use as Basic Operation Tool
URIT	Use as Research and Information Seeking Tool
UTAUT	Unified Theory of Acceptance and Use of Technology
UTeM	Universiti Teknikal Malaysia Melaka
UTHM	Universiti Tun Hussein Onn Malaysia
VGA	Video Graphics Array
Wi-Fi	Wireless Fidelity
χ^2	Chi-Square Statistic

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

The use of computer-based technology has started with the inception of desktop computers. However, desktop computers are mostly used as tools that add to the educators' repertoire to support teaching and to meet the students' needs (Song, Wang, Li & Yuan, 2013). Meanwhile, the desktop computer is used by students to elicit information and participate in online activities within a static and wired environment (Osman, Masran, Hashim & Taib, 2011a). Eventually, with the birth of the Internet followed with the arrival of the World Wide Web, the use of technology has evolved in a form of a wired environment which has been around for ages, to a wireless environment which has been gaining popularity in recent years. By 2010, more than 530 million mobile technology inventions such as laptops and mobile phones were interconnected through Internet in over 180 countries. The number continues to grow at a dramatic rate in 2012 (Johnson et al., 2013). This type of technology also known as a 'mobile technology' can benefit students in creating an exciting and challenging atmosphere both in and outside the classroom. Students therefore, are keener in using this new technology replacing the use of desktop computers (Bonk & Graham, 2012).

In this 21st century and with the fast-paced development of computer technology, students have thrived more on mobility. The students expect to be able to take their technology with them wherever they go. This gives them immediate gratification and to get feedback as well as information straight away (Marinagi, Skourlas & Belsis, 2013; Margaryan, Littlejohn & Vojt, 2011). The students also demand constant connections when using technology either for social or academic lives (Oblinger, Oblinger & Lippincott, 2005) and have their ideal vision on how to make their daily activities more engaging by using the most updated technology. The students also want their learning environment to look more like the 'world' in which they now live to use technology anywhere and anytime (Beetham & Sharpe, 2013). Therefore, the introduction of 'ubiquitous technology' in education is due to these demands and needs.

This ubiquitous technology also refers to 'u-tech' by Kuo and Chou (2010) which is identified as a new and updated technology in the information and communication world. Ubiquitous technology (henceforth u-tech) is normally associated with small and mobile electronic devices which have communication and computation capabilities such as smartphones, handheld devices such as tablets and Radio Frequency Identification (RFIDs) (Koshizuka & Sakamura, 2010). Most u-tech is equipped with sensors, allowing the technology to interact with the environment and its users. With the advent of u-tech, learning has also evolved from electronic learning (e-learning) to mobile learning (m-learning) and subsequently to ubiquitous learning (u-learning). With reference to the learning dimensions by Lyytinen and Yoo (2002), it was observed that e-learning provides low mobility due to the use of desktop computers and therefore, the learning environment is fixed. Meanwhile, m-learning is basically about inclining learners' aptitude to learn outside the classroom environment. However, this learning only takes place in a particular wireless fidelity (Wi-Fi) hotspots via wireless devices such as Personal Digital Assistants (PDAs) or laptop computers (Dochev & Hristov, 2006).

Lyytinen and Yoo (2002) defined u-learning as ‘anywhere and anytime learning’ which refers to any environment that allows new and advanced learning devices to access acquisition of knowledge via wireless networks. U-learning is commonly based on the use of u-tech and the most significant role of u-tech is the construction of a conducive learning environment, which enables learners to learn at anyplace anytime (Marinagi et al., 2013; Yahya, Ahmad & Abd Jalil, 2010). The most popular u-tech used by many are laptops (Awwad, Ayesh & Awwad, 2013; Rosen & Beck-Hill, 2012), smartphones (Rahamat et al., 2013; Backer, 2010) and tablet computers or tablets (Lee, 2014; Zain, Mahmud & Hassan, 2013; Singh, 2013). Apart from that, PDAs (Jasper et al, 2012; Shariffudin, Julia-Guan, Dayang, Mislán & Lee, 2012), MPEG audio layer III or MP3 (Matias & Wolf, 2013; Tan, Lim & Goh, 2012) and smart boards (Singh & Mohamed, 2012; Al-Qirim, 2011) are others examples of u-tech used either for teaching and learning or for leisure and entertainment purposes.

1.1.1 Ubiquitous Technology (U-Tech)

In general, u-tech is a refined mobile tool with multiple functions including Internet services, digital camera, video recording and the Global Positioning System (GPS) navigation (Zhou, Zhang, Jiang & Freeh, 2011). These features make the lives of users easier, as there is surety that they have constant access to the computer and Internet and get everything they need in one device (Lance, 2012). For learning, u-tech permits students to gain the latest and most accurate information faster and more easily with Internet ability (Benson & Morgan, 2013). Besides, students can also experience learning in a real-world environment outside the physical classroom and remain connected with their family, lecturers, friends and community (Norman, Din & Nordin, 2011).

U-tech is also viewed as a versatile tool, combining the mobility and connectivity of many elements such as powerful processors which enable students to organise and conduct a number of computing tasks simultaneously; such as dealing with calculating statistics or with complex mathematical equations and at the same time browsing the web and listening to music (Yahya et al., 2010). U-tech is commonly handheld, lightweight and portable, therefore enabling students to take the technology anywhere they like (Moran, Hawkes & El-Gayar, 2010). The features included in u-tech are very interactive due to its colourful interface, speed, response and its ability to provide immediate feedback (Gikas & Grant, 2013; Corona, Cozzarelli, Palumbo & Sibilio, 2013).

It is paramount for students in the institution of higher learning to fully utilise the advance mobile technology such as u-tech. This technology is believed to be very beneficial for fostering technology competency and other skills such as communication, collaboration, critical thinking, problem solving and decision making that needed by future employers (Male, Bush & Chapman, 2010; Megat Johari et al., 2002). In the same vein, the importance of preparing fresh graduates with the necessary technology competency is also reflected in the Malaysian Information Communication and Technology (ICT) Policy (2004). This ICT policy emphasises the importance of producing a new breed of knowledgeable, skilful and competent workers for the 21st century through the utilisation of latest technology in learning (Shariffadeen, 2004).

1.1.2 Ubiquitous Technology Utilisation

Learning and requiring information are more meaningful if it is acquired through interaction between the individual and the environment (Howland, Jonassen & Marra, 2012). Thus, with the advancement and deployment of new technology such as u-tech, the process of conducting various activities simultaneously has become easier. For instance, a student equipped with a technology can connect to any other devices and access the network by using wireless communication technologies. Here, technology allows the process of communication, collaboration and information-sharing to ensue naturally, constantly and continuously (Weiser, 1993).

According to Lei, Shen and Johnson (2014), the use of new technology should not only focus on how much, how often, but most importantly on how the technology is being used. In 2007, the International Society for Technology in Education (ISTE) developed the National Educational Technology Standards for students (NETS.S) which provides the benchmark for technology usage in enhancing and promoting various important skills. In NETS.S, there are six categories on how new technology can be used effectively for activities related to (i) operation and concepts, (ii) research and information fluency, (iii) communication and collaboration, (iv) digital citizenship, (v) critical thinking, problem-solving and decision-making, and (vi) creativity and innovation.

According to ISTE, the operation and concepts category refers to the use of technology for basic and general tasks such as making call, sending electronic email (e-mail) and downloading files. The research and information fluency category refers to the use of technology to gather, evaluate and seek information purposes. Meanwhile, the communication and collaboration category refers to the use of technology to interact and work collaboratively. The digital citizenship category refers to the use of technology to gain knowledge on issues related to technology and ethical behaviour. The critical thinking, problem-solving and decision-making category refers to the use of technology to demonstrate creative thinking, construct knowledge and develop innovative products. Finally, the creativity and innovation category refers to the use of technology to generate creative ideas and new innovation.

As highlighted by the Malaysian Deputy Prime Minister in 2013, the use of new technology is beneficial either to facilitate teaching and learning, as well as to improve the students' collaboration, communication, innovation, problem solving and other important skills. This idea has been supported by various research, that there are many benefits in using u-tech such as to promote flexible in learning and gain information (Beetham & Sharpe, 2013) and increase engagement and motivation (Wankel & Blessinger, 2013; Martin, Ostashewski & Dickinson-Delaporte, 2013).

Flexible learning is described as a practice which utilises the capacities for teacher-learner and learner-learner interaction through developments in information technology and communication (Brand-Gruwel, Kester, Kicken & Kirschner, 2014). Collis and Moonen also (2002) stressed that the use of technology should in line with a model of flexible learning. With the use of present and new computer technology students are able to flexibly customise, make decisions and show responsibility for their own learning and manage learning either asynchronously or synchronously. Synchronous learning transpires in real-